ED_000545OneDrive_00006091

EPAct Program

Fuel Matrix Design Options

July 31, 2007

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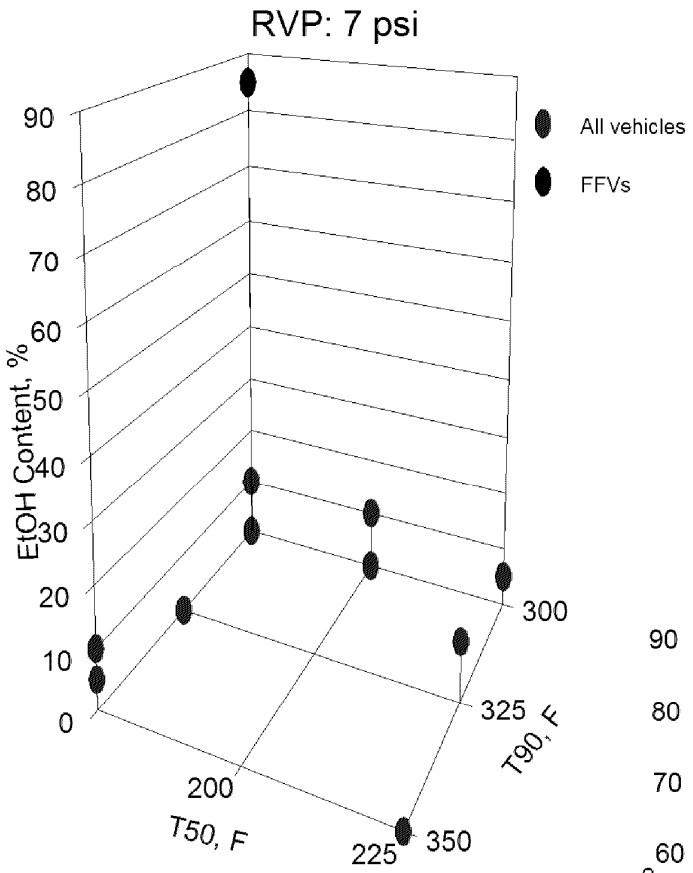
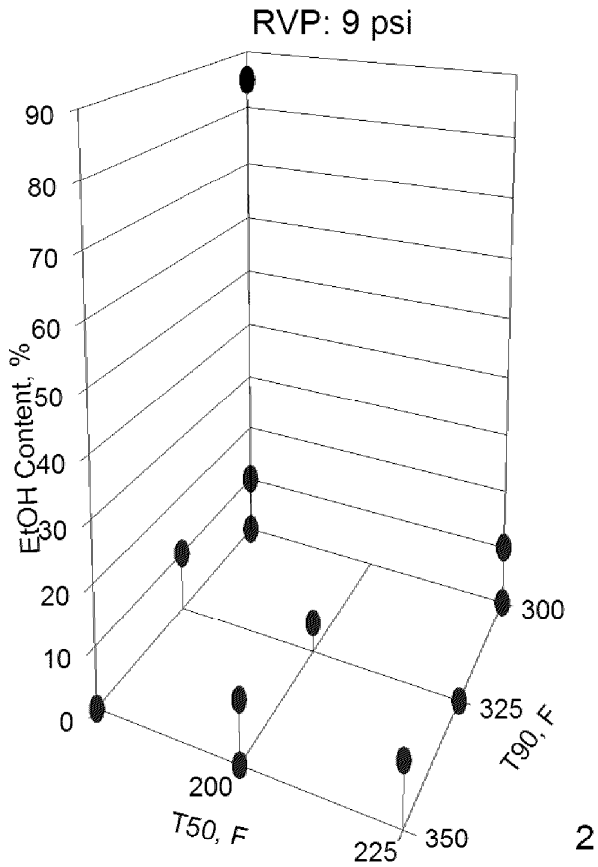
Fuel Matrix No.1A
(4 variable, mixed level (3x3x3x2))



- Computer generated optimal design
- 21(23) fuels
- G-Efficiency*: 87.7%

* >60% considered satisfactory

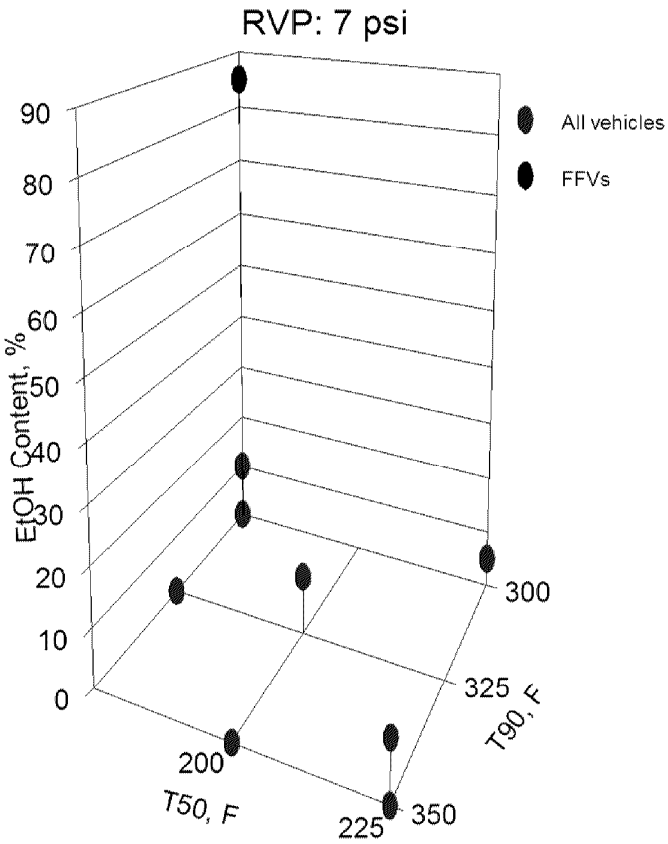


Fuel Matrix Design

Fuel Variables	# of Levels	Terms in Model
T50	3	Main effects, $T50^2$, $T90^2$, $EtOH^2$, T50*EtOH, T90*EtOH, RVP*EtOH
T90	3	
EtOH	3	
RVP	2	

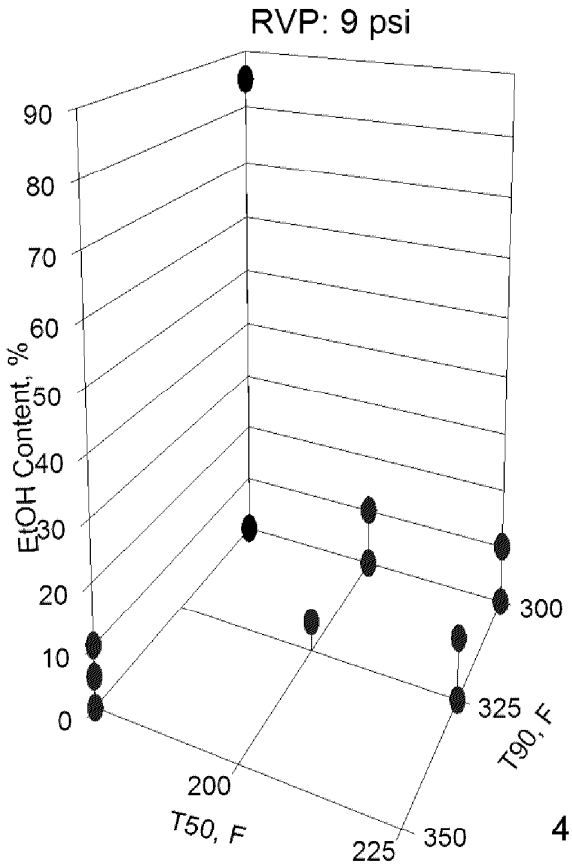
Ex. 5 - Deliberative/Ex. 4 CBI

Fuel Matrix No.1B
(4 variable, mixed level (3x3x3x2))



- Computer generated optimal design
- 18(21) fuels
- G-Efficiency*: 73.6%

* >60% considered satisfactory



Fuel Matrix Design

Fuel Variables	# of Levels	Terms in Model
T50	3	Main effects, $T50^2$, $T90^2$, $EtOH^2$, T50*EtOH, T90*EtOH, RVP*EtOH
T90	3	
EtOH	3	
RVP	2	

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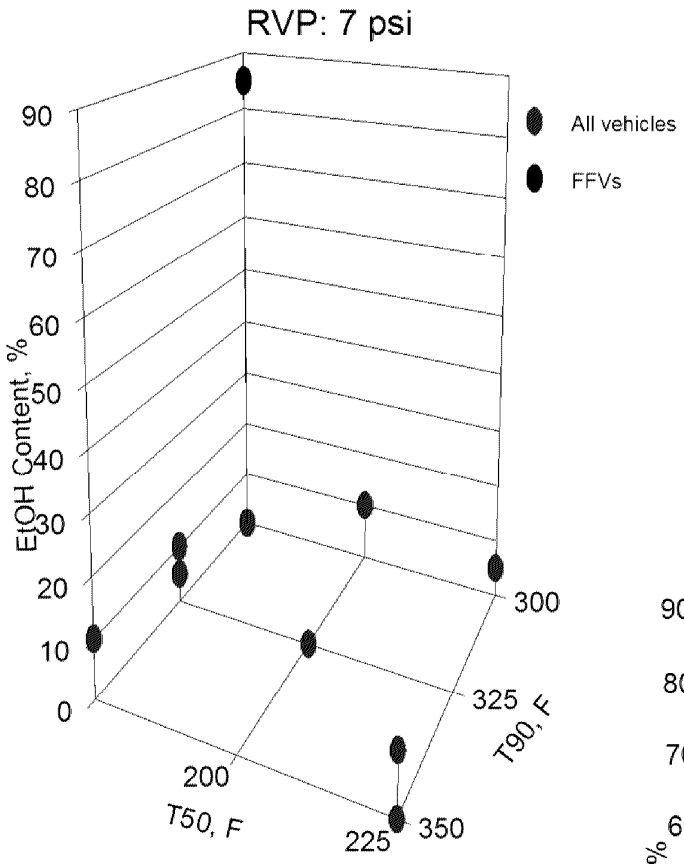
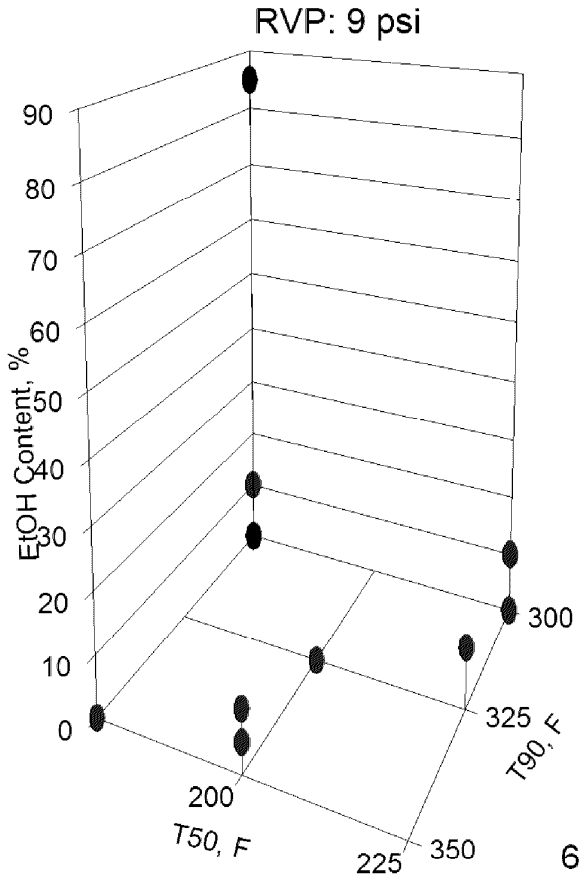
Ex. 5 - Deliberative/Ex. 4 CBI

Fuel Matrix No.1C
(4 variable, mixed level (3x3x3x2))



- Computer generated optimal design
- 17(20) fuels
- G-Efficiency*: 72.5%

* >60% considered satisfactory



Fuel Matrix Design

Fuel Variables	# of Levels	Terms in Model
T50	3	Main effects, $T50^2$, $T90^2$, $EtOH^2$, T50*EtOH, T90*EtOH, RVP*EtOH
T90	3	
EtOH	3	
RVP	2	

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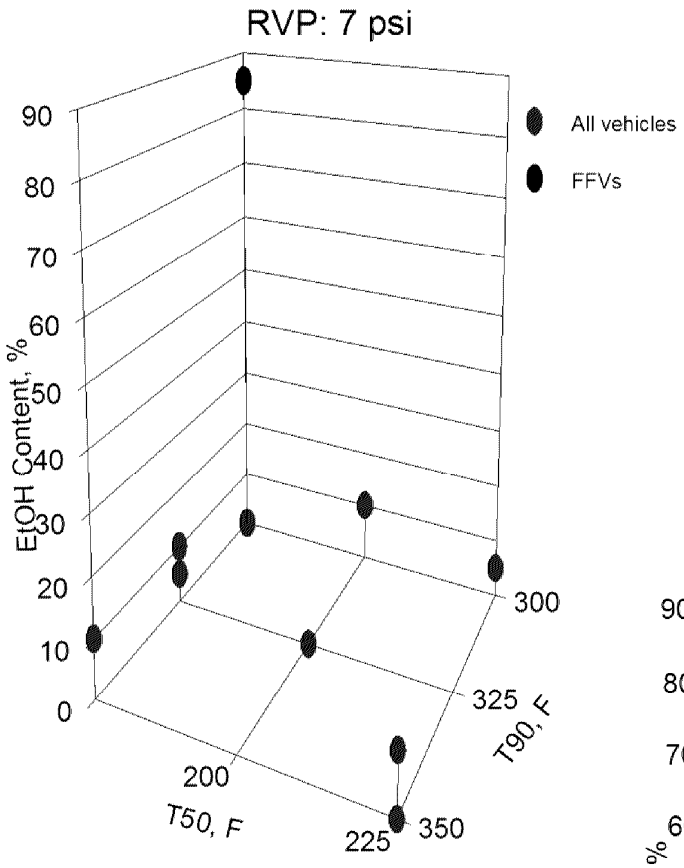
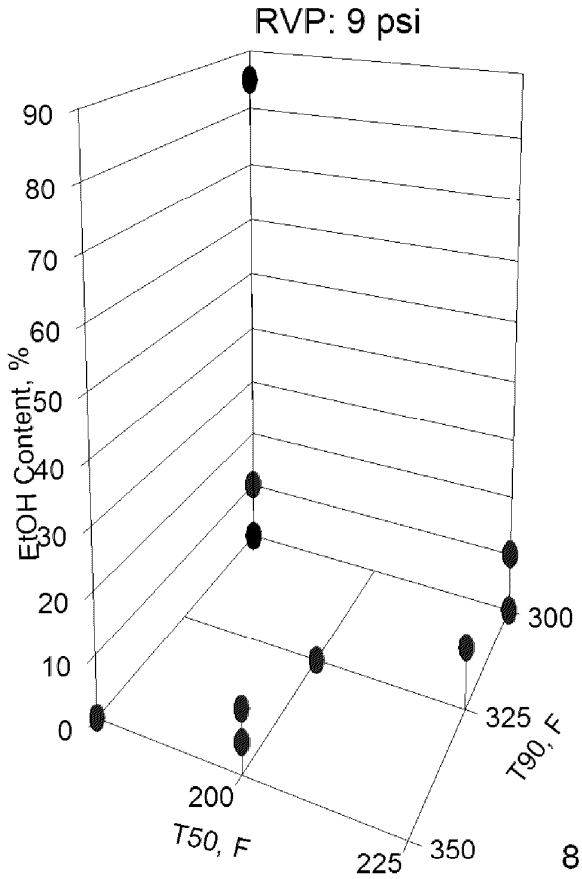
Ex. 5 - Deliberative/Ex. 4 CBI

Fuel Matrix No.1D
(4 variable, mixed level (3x3x3x2))



- Computer generated optimal design
- 17(20) fuels
- G-Efficiency*: 72.5%

* >60% considered satisfactory



Fuel Matrix Design

Fuel Variables	# of Levels	Terms in Model
T50	3	Main effects, $T50^2$, $T90^2$, $EtOH^2$, T50*EtOH, T90*EtOH, RVP*EtOH
T90	3	
EtOH	3	
RVP	2	

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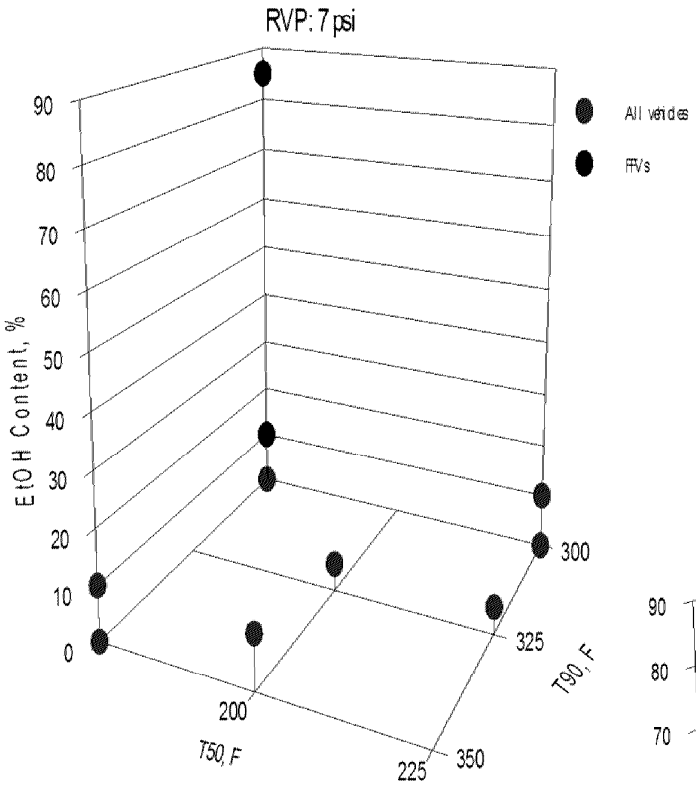
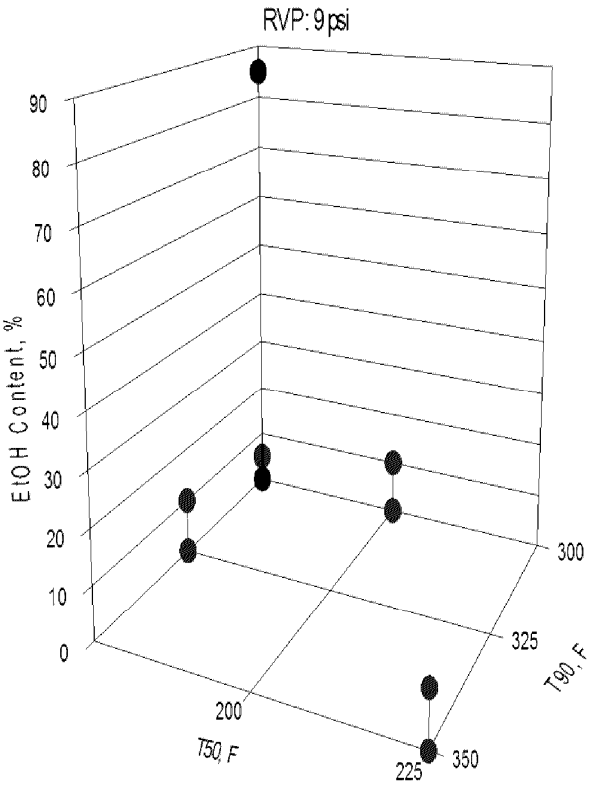
Ex. 5 - Deliberative/Ex. 4 CBI

Fuel Matrix No.1E
(4 variable, mixed level (3x3x3x2))



- Computer generated optimal design
- 15(18) fuels
- G-Efficiency*: 58.8%

* >60% considered satisfactory

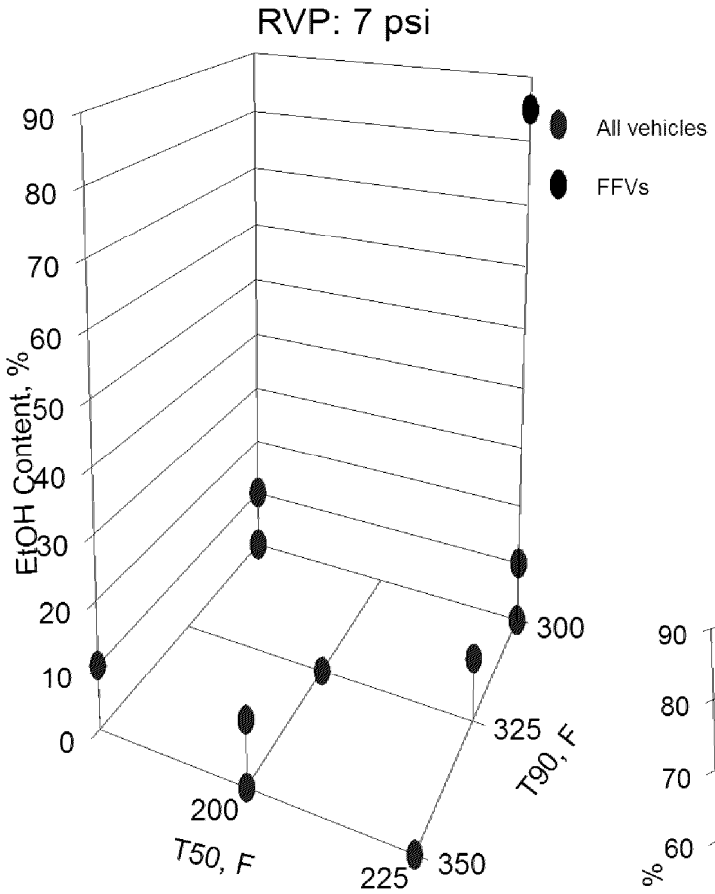


Fuel Matrix Design

Fuel Variables	# of Levels	Terms in Model
T50	3	Main effects, $T50^2$, $T90^2$, $EtOH^2$, T50*EtOH, T90*EtOH, RVP*EtOH
T90	3	
EtOH	3	
RVP	2	

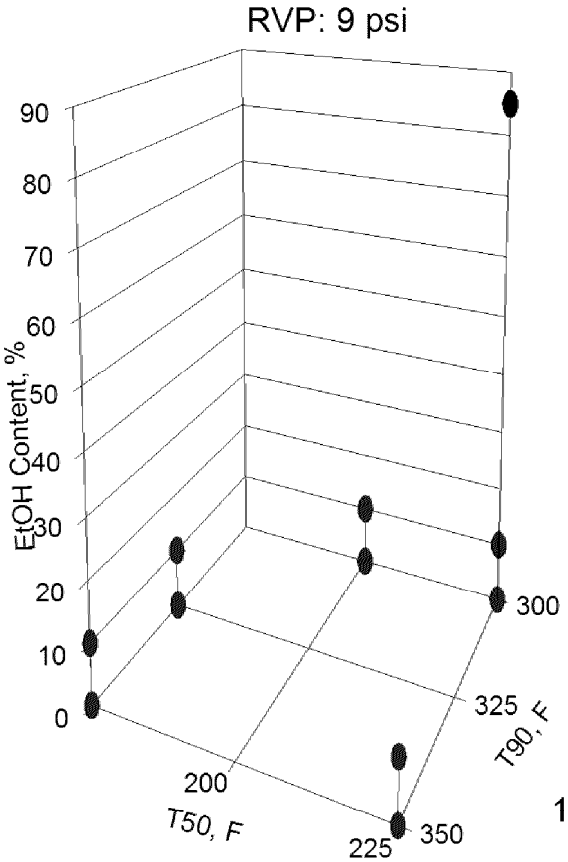
Ex. 5 - Deliberative/Ex. 4 CBI

Fuel Matrix No.3A
(4 variable, mixed level (3x3x2x2))



- Computer generated optimal design
- 20(22) fuels
- G-Efficiency*: 86.4%

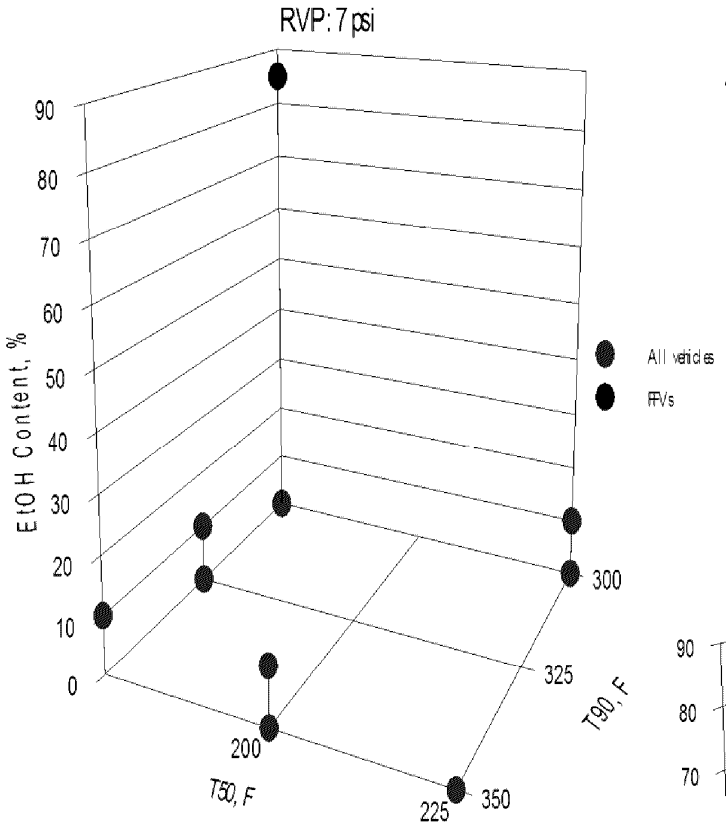
* >60% considered satisfactory



Fuel Variables	# of Levels	Terms in Model
T50	3	Main effects, $T50^2$, $T90^2$, T50*EtOH, T90*EtOH, RVP*EtOH
T90	3	
EtOH	2	
RVP	2	

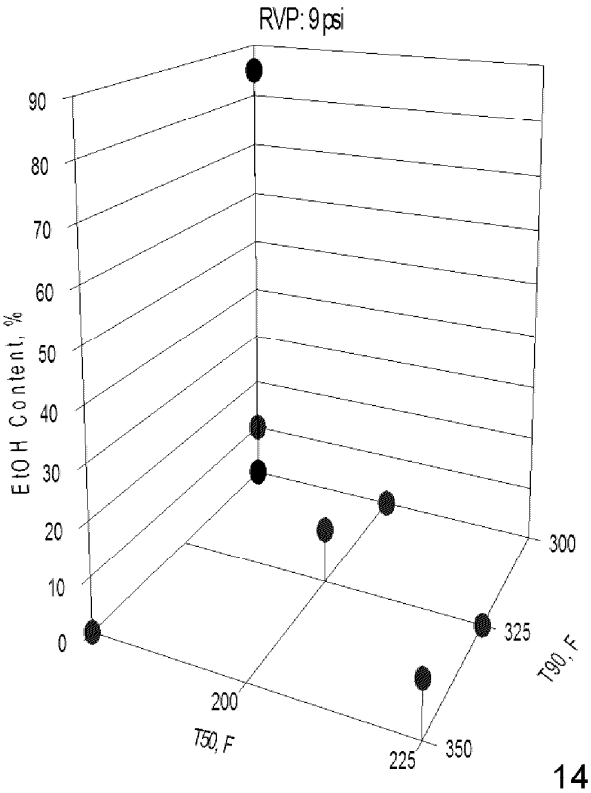
Ex. 5 - Deliberative/Ex. 4 CBI

Fuel Matrix No.3B
(4 variable, mixed level (3x3x2x2))



- Computer generated optimal design
- 15(18) fuels
- G-Efficiency*: 69.9%

* >60% considered satisfactory



Fuel Variables	# of Levels	Terms in Model
T50	3	Main effects, $T50^2$, $T90^2$, T50*EtOH, T90*EtOH, RVP*EtOH
T90	3	
EtOH	2	
RVP	2	

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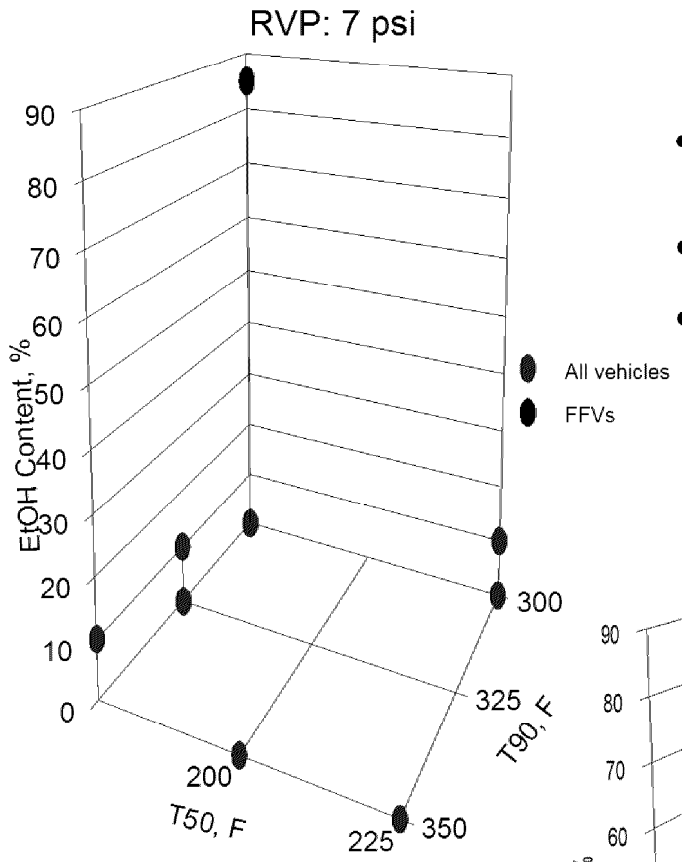
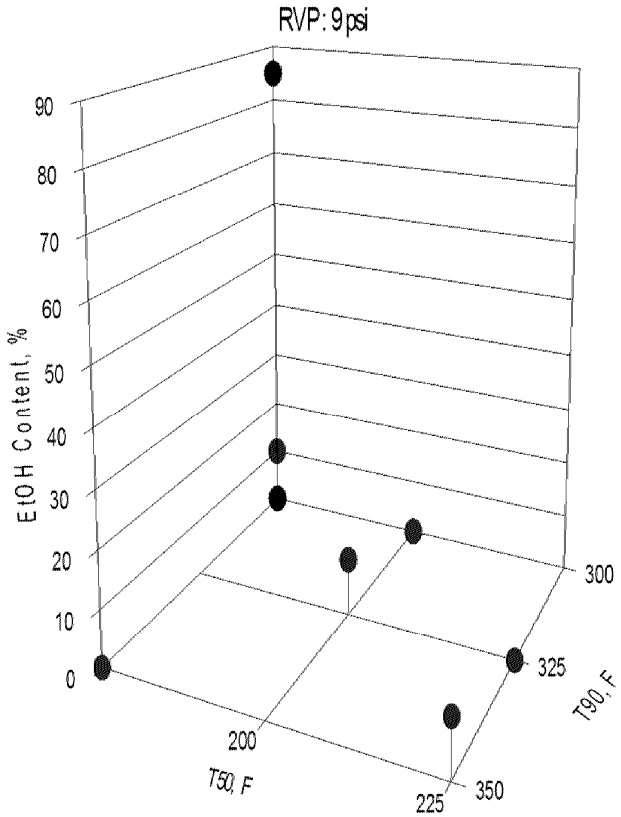
Ex. 5 - Deliberative/Ex. 4 CBI

Fuel Matrix No.3C
(4 variable, mixed level (3x3x2x2))



- Computer generated optimal design
- 14(17) fuels
- G-Efficiency*: 63.7%

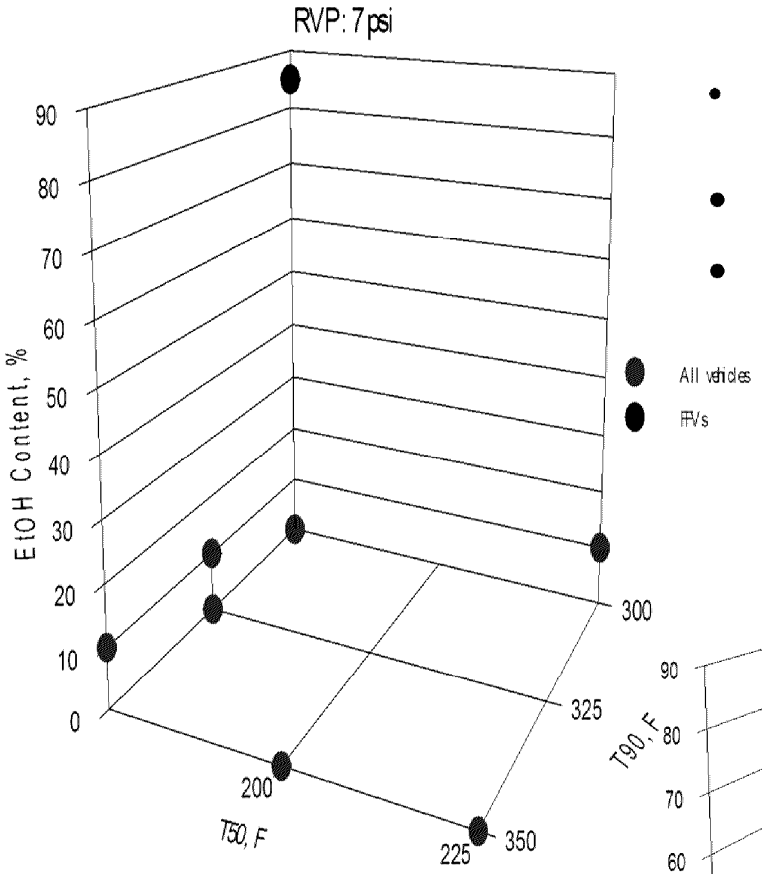
* >60% considered satisfactory



Fuel Variables	# of Levels	Terms in Model
T50	3	Main effects, $T50^2$, $T90^2$, T50*EtOH, T90*EtOH, RVP*EtOH
T90	3	
EtOH	2	
RVP	2	

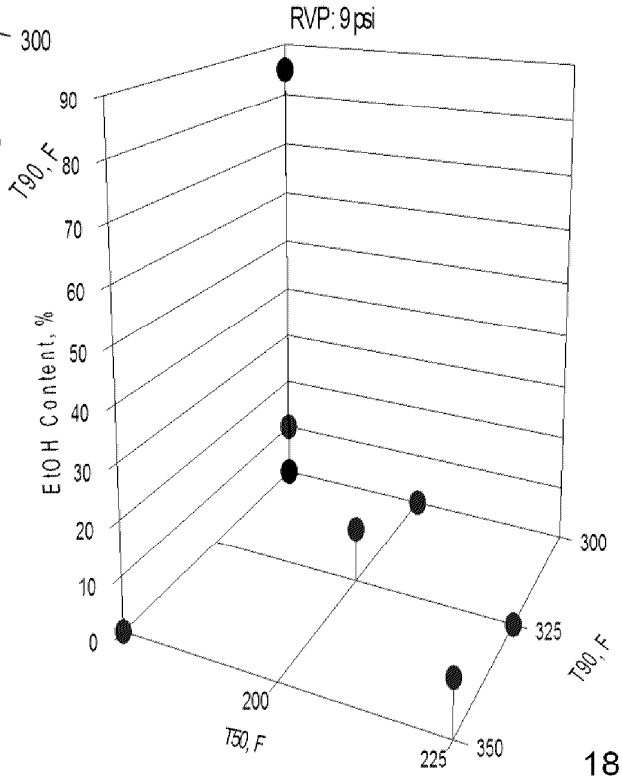
Ex. 5 - Deliberative/Ex. 4 CBI

Fuel Matrix No.3D
(4 variable, mixed level (3x3x2x2))



- Computer generated optimal design
- 13(16) fuels
- G-Efficiency*: 59.2%

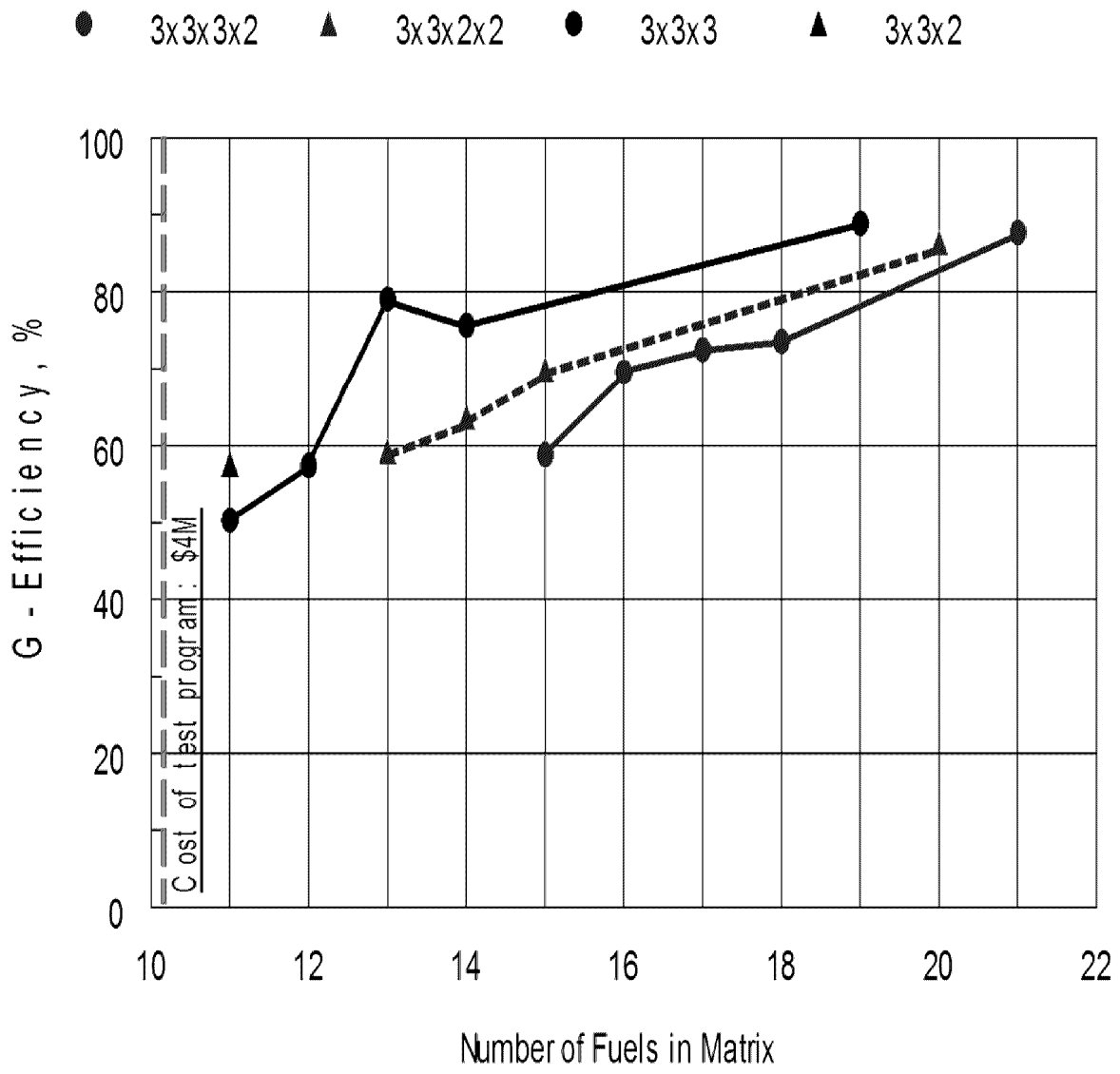
* >60% considered satisfactory



Fuel Variables	# of Levels	Terms in Model
T50	3	Main effects, $T50^2$, $T90^2$, T50*EtOH, T90*EtOH, RVP*EtOH
T90	3	
EtOH	2	
RVP	2	

Ex. 5 - Deliberative/Ex. 4 CBI

G-Efficiency vs. Number of Fuels in the Matrix



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G-Efficiency vs. Number of Fuels in the Matrix

Designation	Number of Variables	Levels per Variable	Number of Fuels *	G - Efficiency	
1a	4	3 x 3 x 3 x 2	21(23)	87.7	
1b	4	3 x 3 x 3 x 2	18(21)	73.6	
1c	4	3 x 3 x 3 x 2	17(20)	72.5	
1d	4	3 x 3 x 3 x 2	16(19)	69.6	
1e	4	3 x 3 x 3 x 2	15(18)	58.8	
3a	4	3 x 3 x 2 x 2	20(22)	86.4	
3b	4	3 x 3 x 2 x 2	15(18)	69.9	Ex. 4 - CBI
3c	4	3 x 3 x 2 x 2	14(17)	63.7	
3d	4	3 x 3 x 2 x 2	13(16)	59.2	
2a	3	3 x 3 x 3	19(20)	88.9	
2b	3	3 x 3 x 3	14(15)	75.7	
2c	3	3 x 3 x 3	13(14)	79.1	
2d	3	3 x 3 x 3	12(13)	57.4	
2e	3	3 x 3 x 3	11(12)	50.3	
4a	3	3 x 3 x 2	11(12)	57.5	

* Numbers in parentheses include additional fuels tested in FFVs only

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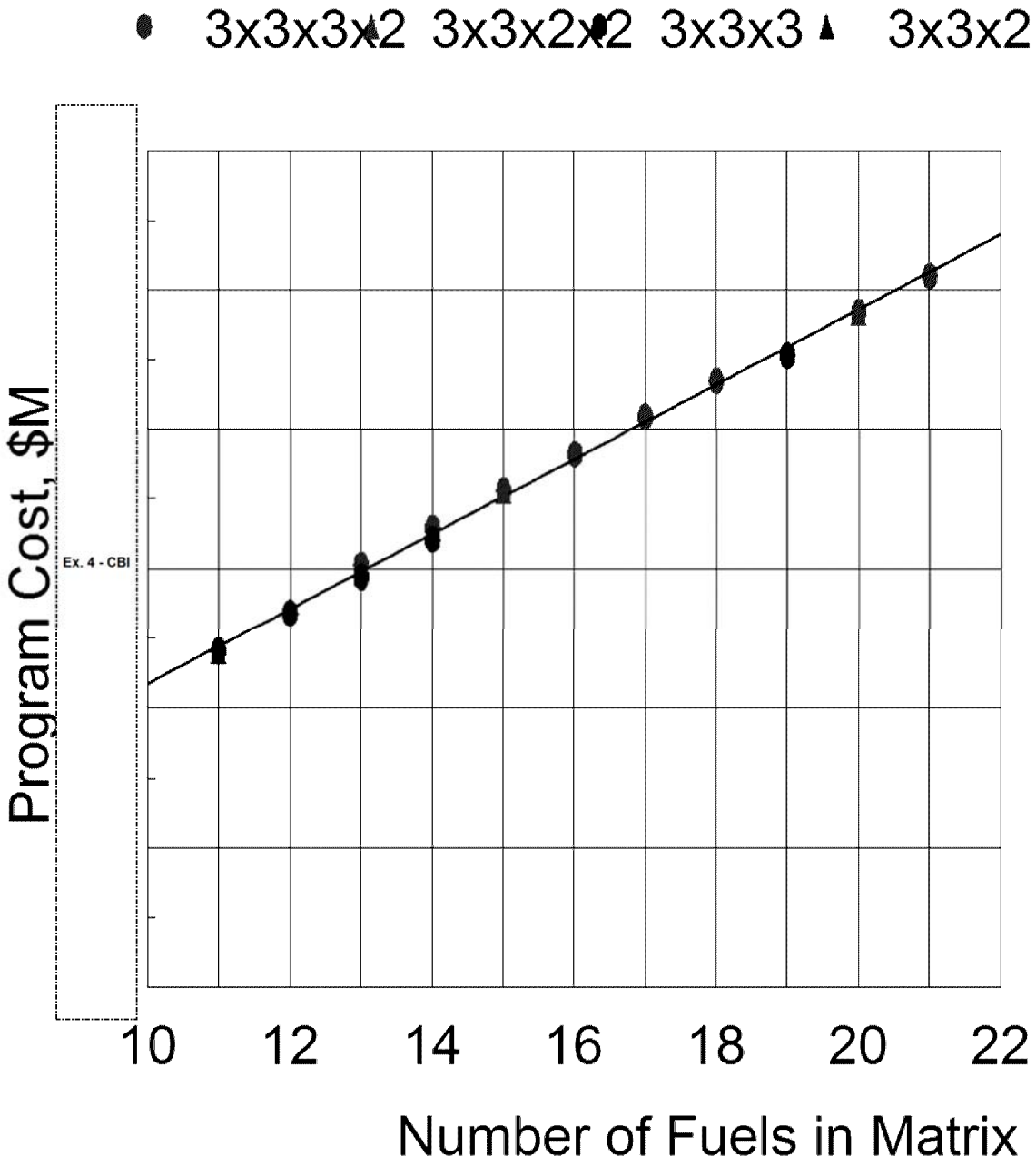
Program Cost vs. Number of Fuels in the Matrix



Options

- Remove RVP from EPAct Program
  - Use E-74b data instead
- Remove T50 and T90
  - Use E-67 data instead
- Remove FFV tests at E>10
  - Use E-80 data instead
- Remove high emitters
- Remove 50°F test temperature
- Incorporate E20 in the program and utilize DOE support

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CRC Program E-67

- Title: Effects of Ethanol and Volatility Parameters on Exhaust Emissions
- Status: Completed
- Fuel parameters investigated: T50 (195, 215, 235°F), T90 (295, 330, 355°F), ethanol (0, 5.7, 10%)
- Test vehicles:
  - 6 CA cert. LEVs, incl. 3 LDTs
  - 5 CA cert. ULEVs, incl. 2 LDTs
  - 1 CA cert. SULEV LDV
  - 5 LDVs at Tier 2 emission levels
- Test cycle: FTP
- Exhaust constituents measured: NMHC, CO, NOx, selected toxics for 4 vehicles
- Exhaust constituents not measured: PM, sec/sec emissions

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CRC Program E-74b

- Title: Effect of Vapor Pressure and Temperature Parameters on CO Exhaust Emissions
- Status: In –progress (~50% done)
  - Completion expected in 3Q 2007
- Fuel parameters investigated: RVP (7-9(13) psi), ethanol (0, 10, 20%)
- Test vehicles:
  - 3 Tier 1s, incl. 1 LDT
  - 5 NLEVs, incl. 2 LDTs
  - 7 Tier 2s, incl. 3 LDTs
- Test cycle: FTP at 75 and 50°F
- Exhaust constituents measured: NMHC, CH_4, CO, NOx
- Exhaust constituents not measured: PM, toxics, sec/sec emissions

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CRC Program E-80

- Title: Exhaust and Evaporative Emissions Testing of Flexible Fuel Vehicles
- Status: To be launched in 4Q 2007
  - Expected program duration: 18 months
- Test Fuels:
  - Commercial CA E6
  - Commercial CA E85
  - Up to 3 co-mingled blends of E6 and E85
- ~ 10 CA-certified, late-model FFVs
- Test cycles: FTP, SFTP, LA92, two-day CA diurnal incl. hot soak test
- Exhaust constituents measured: NMHC, CH_4, CO, NOx, toxics, sec/sec emissions (?)
- Exhaust constituents not measured: PM

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Vehicle Selection

- Based on MY engine family sales data
  - Usually multiple models to choose from for each engine family
  - High volume sellers are, by definition, representative, and should ease recruitment
- Data available for MY 04 – 06 Tier 2 and LEV 2, plus NLEV data from 2000 +
- Plan to provide table of vehicles for contractor to choose from for given MY and mileage target

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Sample Vehicle List (05/06)

Engine Family	MANUFACTURER	Model(s)	Tier 2 Sales
5GMXX03.8148	SATURN	Grand AM, Bonneville, Monte Carlo, Relay, G6, Impala, LeSabre	94367
5GMXT06.0187	ISUZU	Yukon XL, Silverado, Trailblazer, Escalade	52856
6GMXB03.9146	SATURN	Relay, G6, Malibu Maxx, Equinox, Rendezvous	47508
5FMXT05.4R7	LINCOLN	Navigator, F150, Expedition	36806
5CRXT03.8NED	DODGE	Caravan, Pacifica, Town & Country - 2005 or 2006	33706
6GMXX02.4029	SATURN	Ion, Cobalt	33664
6GMXT05.3379	GMC	Yukon, Sierra, Silverado, Suburban, Tahoe	30704
6TYXX01.8FEA	TOYOTA	Corolla, Matrix - 2005 or 2006	27806
6FMXT05.4R7	FORD	Navigator, F150, Expedition	25883
6GMXX03.9048	PONTIAC	GRAND PRIX, MONTE CARLO, IMPALA	25887
5CRXX02.4VED	DODGE	Neon, Stratus, Sebring, PT Cruiser - 2005 or 2006	23648
5NSXX02.5G5A	NISSAN	ALTIMA	23210
6TYXT03.3EEM	TOYOTA	Sienna, Highlander - 2005 or 2006	22819
5CRXT03.7NED	JEEP	Liberty, Cherokee, Grand Cherokee	22457
5GMXT04.2185	ISUZU	Envoy, Trailblazer, Rainier, Ascender - 2005 or 2006	21903
5TYXX02.4FEB	TOYOTA	Camry, Solara	21545
6NSXX02.5G5A	NISSAN	ALTIMA	20598
6HNXX01.8JKR	HONDA	CIVIC	20291
6HNXT03.5TKR	HONDA	Pilot, Odyssey	18541
5FMXX02.31D4	FORD	Focus	18162
5HNXX02.4VEP	HONDA	ACCORD - 2005 or 2006	17902
5GMXX02.2026	SATURN	Ion, Cobalt	17365
5FMXX03.02EC	LINCOLN/MERCU	Five hundred, Freestyle, Montego	17038
5GMXT05.3175	GMC	Yukon, Sierra, Tahoe, Silverado, Avalanche, Suburban	15868
6TYXT04.0NEM	TOYOTA	Tundra, Tacoma, 4Runner	18156
6CRXT03.7NED	JEEP	Liberty, Cherokee, Grand Cherokee	17533
6CRXX03.5VH0	DODGE	Magnum, Charger	15921

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Vehicle Fleet Sizing

- Based on risk analysis
  - Same type of analysis was used in AutoOil Program
- Depends on assumed emissions difference which should be readily detectable as significant
- Requires estimates of the following parameters:
  - Test-to-test variability
  - Vehicle-to-vehicle variability among vehicles of the same model
- Test data needed to define fleet size available in-house

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